VOL. 5 NO. 7

AMERICAN JOURNAL OF OPTOMETRY

# NOTES ON THE RELATION BETWEEN ACCOMMODATION, FUSION AND ADDUCTION

W. S. Farmer, Opt.D.
Oklahoma City, Oklahoma

*Convergence*

By convergence, as I understand the term, is meant the power of directing and holding the visual lines or axis of the two eyes toward a single point; it is the first step in the visual act of single binocular vision, and acts as a range finder, moving the two eyes in proper position for action. This is accomplished by the action of internal rectus muscles assisted and guided by the oblique and external rectus muscles. The function of convergence is to always maintain single binocular vision, at all distances. See chart No. 1.

Convergence is more important than its co-worker, accommodation. These two functions, are in ordinary life, always used together, so that they have become "associated" by hereditary and individual habits. It is difficult, yet possible, therefore, for a normal pair of eyes to accommodate without converging, or to converge without accommodating; however, there is a variable amount of each that can be exerted without the other; perhaps they are more like two members of a family, closely related, yet each having individual freedom.

Relative convergence is that amount that can be used, exerted or repressed, without straining this relationship. Indeed, if this were not so, every high hyperope, who accommodates to correct his error, would also "over converge," and become an esotrope; but in many cases, his relative convergence saves him from this condition. Convergence is a voluntary action, it is both conscious and subconscious, being innervated principally by the third and fourth nerves, and is under the direct control of the mind. Convergence is measured by moving a small object, 2 to 5 mm. in diameter, toward the eyes until

VOL. 5 NO. 7

AMERICAN JOURNAL OF OPTOMETRY

# NOTES ON THE RELATION BETWEEN ACCOMMODATION, FUSION AND ADDUCTION

W. S. Farmer, Opt.D.
Oklahoma City, Oklahoma

*Convergence*

By convergence, as I understand the term, is meant the power of directing and holding the visual lines or axis of the two eyes toward a single point; it is the first step in the visual act of single binocular vision, and acts as a range finder, moving the two eyes in proper position for action. This is accomplished by the action of internal rectus muscles assisted and guided by the oblique and external rectus muscles. The function of convergence is to always maintain single binocular vision, at all distances. See chart No. 1.

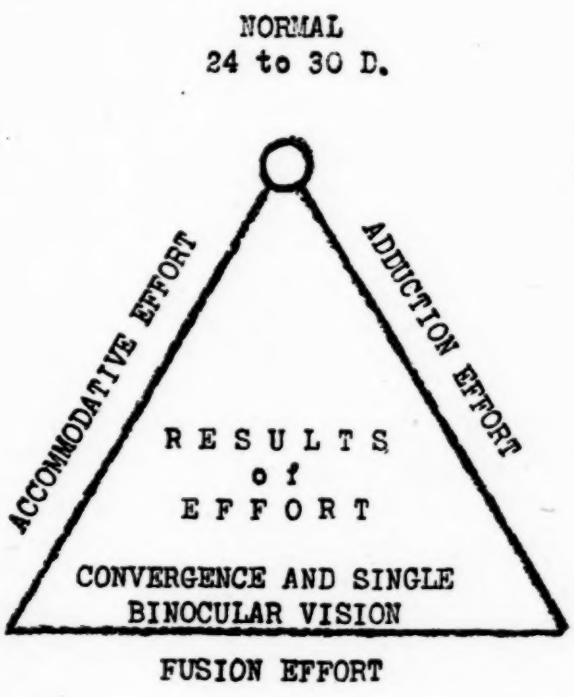
Convergence is more important than its co-worker, accommodation. These two functions, are in ordinary life, always used together, so that they have become "associated" by hereditary and individual habits. It is difficult, yet possible, therefore, for a normal pair of eyes to accommodate without converging, or to converge without accommodating; however, there is a variable amount of each that can be exerted without the other; perhaps they are more like two members of a family, closely related, yet each having individual freedom.

Relative convergence is that amount that can be used, exerted or repressed, without straining this relationship. Indeed, if this were not so, every high hyperope, who accommodates to correct his error, would also "over converge," and become an esotrope; but in many cases, his relative convergence saves him from this condition. Convergence is a voluntary action, it is both conscious and subconscious, being innervated principally by the third and fourth nerves, and is under the direct control of the mind. Convergence is measured by moving a small object, 2 to 5 mm. in diameter, toward the eyes until

diplopia occurs, then converting this distance into prism dioptres. This is the measurement of the maximum convergence of a particular individual in prism dioptres. Example: convergence near point 4 inches equals 10 meter angles or 30 prism dioptres.

*Adduction*

Adduction is a physiological term, and signifies the turning of the eyes inward, toward the median line of the body, by the internal




rectus muscles—muscular mechanism of convergence. However, a distinction should be made between convergence and adduction; both are innervated and muscular acts. Convergence is a normal physiological act unconsciously practiced by every normal individual, whereas, adduction is an abnormal drawing together of the visual axis against resistance (prisms furnishing the resistance).

We have all noticed cases of fair adduction power combined with weak convergence at near, and *vice versa*. Pure or relative adduction power is seldom higher than 15 to 20 prism dioptres, while natural convergence in a normal person, is usually 30 or more

prism dioptres. Adduction is a voluntary act, and is measured by the strongest prism base-out, before either or both eyes, that does not produce "blur" or diplopia, at a distance of 20 feet.

The difference in adduction and convergence should be kept in mind, since adduction is one source of stimulation for convergence. True adduction stimulation for convergence ends when "blur" begins in the distant test; this is the point where accommodation begins to stimulate convergence.

*Accommodation*

Accommodation is the involuntary act of keeping the eye in focus at different distances. It is a normal subconscious function associated with convergence, and reinforced by the fusion sense. The power of accommodation reaches its maximum at about 14 years of age. From that time on, there is a gradual decline in its power, while the nerve supply and ciliary muscular effort remains about the same; but due to the hardening of the crystalline lens, the results of this effort becomes less and less, until assistance in the form of plus lens is necessary at about the age of 45.

Relative accommodation is the amount of accommodation that can be exerted or forced into play, it is the variable difference between accommodation and convergence that can be exercised or repressed, without breaking up the relationship of these two functions, since convergence remains almost the same throughout life.

The near point of accommodation is the nearest point at which the eye can see distinctly with maximum effort, this distance converted into lens dioptres (when patient is wearing distant correction) gives us the amplitude of accommodation. Usually minus lenses are necessary in finding this near point.

*Fusion*

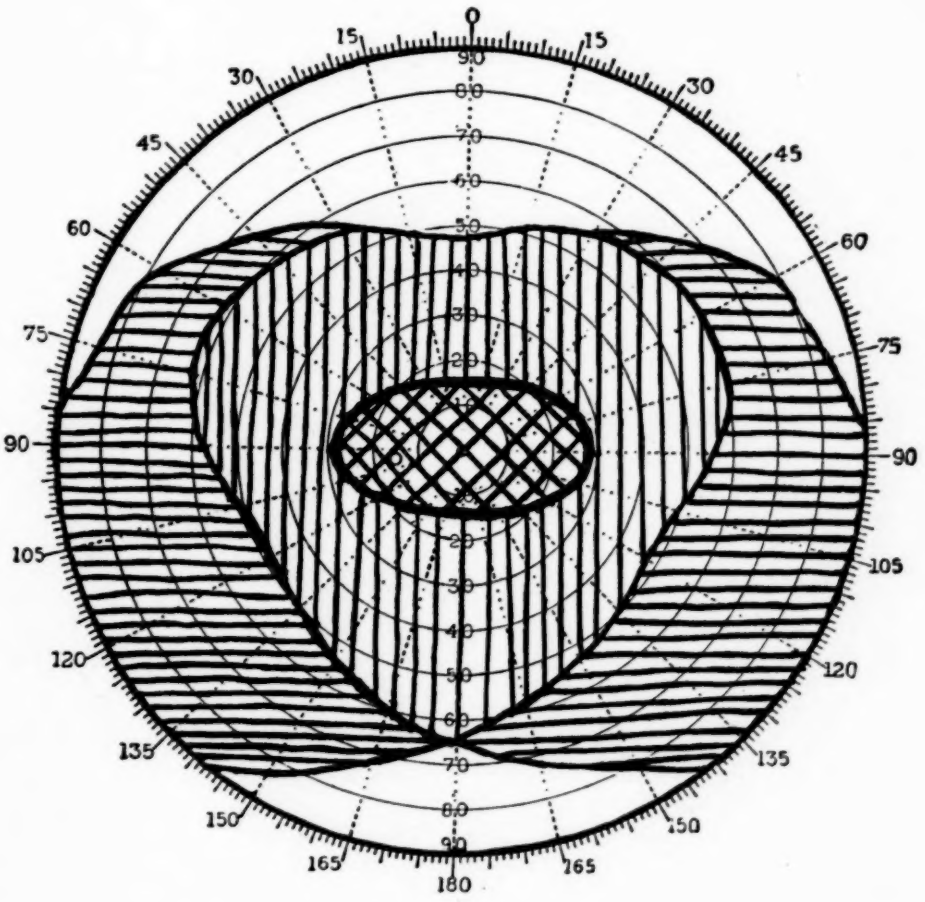
The term fusion as commonly used is the act of melting or blending together of two or more substances; fusion is both physical and psychic.

Anatomy of fusion: The main optic nerve trunk enters the posterior pole of the eye about 15° to the inner side of the macula. In the disc or nerve head, there are no end organs for light perception, but from this point, nerve branches spread out over the interior of the eyeball, however, to the temporal side, the fibers transverse a greater area to reach the periphery, because they bend around the macula region, which is supplied by direct nerve fibers, known as the macula bundle of the main trunk; much the same as an individual telephone wire that is bound together with many others into a cable, yet it never loses its identity.

The rods and cones are perceptive end organs, or nerve endings, like tiny twigs of the main nerve trunk. The macula is a small elongated area near the center of the retina. In the fovea, the most

sensitive part of the macula area, there are no rods, but the fovea is rich with cones, which are more sensitive than rods. Receding from the macula toward the periphery, rods become more numerous, while the cones become fewer in number.

There seems to be three retinal fields, or areas of importance to fusion (see chart No. 2). First, the central or macula area of cones only (fusion area), second, paracentral area of cones and rods (diplopia area), third, peripheral area of rods only (independent area).




[Chart 2. The small central oval indicates the extent of the fusion area for cones only. The area as indicated by vertical lines is with the small central area the approximate field of single binocular vision. In this combined area both rods and cones are used. In the large outer area, as indicated by the horizontal lines, only rods are used in creating retinal impressions, this outer area being the approximate limits of the binocular field.]—FARMER.

The first, or central field being very sensitive, due to cones only, gives us direct central vision, colors, detail and form vision.

The second, or mixed field, seems to be near the limit of the normal color field, and the limit of fusion stimulation or diplopia area.

The central and paracentral areas combined, form the total possible fusion area. An image falling anywhere in this area, of either eye, of a normal pair of eyes, has its corresponding point in the opposite eye, and will be fused as a single image by the two eyes. This area is covered with a rich brown pigment, known as "fuscin." The writer believes that this fuscin acts as an adhesive agent for the two images; we also believe that when this area becomes sluggish and does not react to light stimilus as it should (as in amblyopia) that prismatic fusional exercises will awaken those tiny nerve endings, and stimulate the rods and cones into action, thereby increasing the area of vision or light perception. Perimeter charts (before and after) prismatic exercises of amblyopia, and certain types of constricted fields of vision, will show marked enlargement of these fields.

When an image falls on any part of the paracentral area of either eye, the corresponding point of the opposite, is stimulated; the fusion sense now awake, makes a quick comparison of the two images, and if they are found to be the same, or near the same size, etc., or if they resemble each other, or are complimentary to each other, as red and green, etc., then the two images are fused into one. If, however, there is no similarity of objects as for example a red round light and a white streak of light, the fusion sense notes this, and does not attempt fusion. This second area, we believe, composes the entire single binocular field of vision, as well as the normal monocular color fields. See chart No. 2.

We measure the breadth of the fusional area, by the different duction tests; diplopia is the extreme limit of the fusion area in any direction. This gives us a narrow oblong area, near the center of the retina, longer and wider on the nasal side. We measure the speed of fusion by the refusion of objects after diplopia.

Furthermore, there are three grades of fusion: first, macula perception of both images at the same time, but without breadth or amplitude. Second, true macula fusion, with some breadth, but without perspective or depth. Third, perfect single binocular vision, with stereoscopic relief, breadth, persepective, depth, etc. All of the above grades can be measured with the stereoscope, provided of course, there is binocular vision, not necessarily single binocular vision.

This brings us to the third retinal area, or the extreme temporal field of either eye, the area of rods only, known as the independent or suppression area. An image of a stationary object falling on this

area will not attract attention of the opposite eye, for its corresponding point in the opposite eye is blocked by the nose, there would be no diplopia, the fusion sense is not disturbed. We believe this is the reason that an exotrope soon learns to suppress vision in the poor eye, the eye turning out throws the image on the peripheral area, which has no corresponding point in the fellow eye. In esotropia, we have a condition of the corresponding points not being matched in the fellow eye, in other words, the image points are not identical in the two eyes. However, the third area is of vast importance to our safety, since this is the field of indirect vision and all moving objects from our side are first observed with indirect vision.

Thus we see vision is both physical and psychic, a phenomenon of the mind. Objectively we trace the course of light from the object to the retina, where it ends in the images; and then the sensory course from image to brain, with stations such as the chiasm on the way—we have successfully light, the object, the images, convergence, accommodation, fusion and single binocular vision.

*Conclusion*

Some one has wisely said, "thoughts are things," so we believe adduction, accommodation and fusion are things, at least sources of power or stimulation for convergence and single binocular vision, which is so important to human beings.

These powers or functions have a direct ratio to each other, and can be measured separately; thus when we know the relationship they bear to each other, and the ability of each to perform its allotted task, we can know which power or powers are weak, and toward which function to direct our attention, as well as the type of training needed. Example: while taking adduction with prism base-out, with distant correction in place, object of fixation at 20 feet, patient reports object slightly blurred, we shall say at $8^{\Delta}$, this would be the pure adduction stimulus only, because accommodation is just now beginning to act with adduction. Increasing our prism base-out until diplopia occurs, gives us adduction, accommodative and fusion stimulation combined, say about $32^{\Delta}$. Now we reduce our prism power until the two images fuse into one, about $8^{\Delta}$ to $12^{\Delta}$ base-out. For analysis we now have the following figures representing the separate powers of the individual functions to stimulate and hold single binocular vision 8/32/10. These three sources of stimulation should be about equal; in this particular case, we may consider it as follows: adduction 8, fusion 10, now to get the true accommodation stimulus, we must subtract the adduction and fusion stimulus from the total, which gives us the following results $32 - 18 = 14^{\Delta}$ of accommodation stimulus. We know then that this patient is accommodating "too much," and must be suppressed with plus lenses, to the point of harmony with the adduction and fusional functions.

Sometimes in these tests, we find it is the adduction function that

is at fault, and physiological training of this function is necessary. Again we find the fusional desire weak, then of course our efforts must be directed toward the physchological training of the fusion sense.

Therefore, our great work in optometry is the harmonizing of these three great functions, accommodation, adduction and fusion, thereby producing perfect co-ordination. Our means of training are also three: for accommodation, we use physical means; for adduction, physiological training, and for fusion, psychological training.

## BIBLIOGRAPHY

Claud Worth, "Squint." Fifth Edition.
Luther C. Peter, "Extra-ocular Muscles." 1927 Edition.
David W. Wells, "Stereoscope in Ophthalmology." 1926 Edition.
Geo. A. Rogers, "Muscles of the Eye." 1922 Edition.
Higley, "Cross Eyes."
Carl F. Shepard, "Ocular Psychometry," American Journal of Optometry.
Luther C. Peter, "Principles and Practice of Perimetry," Second Edition.

DR. W. S. FARMER,
FIRST NATIONAL BANK BUILDING,
OKLAHOMA CITY, OKLAHOMA.

# A THEORY ON THE PHYSIO-PSYCHOLOGICAL BASIS OF MINERS' NYSTAGMUS

Fred M. Dula, A.B., M.A., Opt. D.
Morganton, N. C.

This theory is based upon the physiological phenomena which reveal the more complete use of the cone-cells of the retina in daylight vision, and that of the rod-cells in twilight vision.

Without going into a discussion of the physiological facts concerned in these phenomena, we shall state that experiments upon nocturnal birds and animals have shown that in their retinae the rod-cells decidedly predominate over the cone-cells in number and function. Further experiments have revealed that such birds and animals are relatively incapable of reacting to differences between colors—and that their vision is essentially light—and form-vision.

Briefly, then, we accept the fact that cone-cells are media of color-perception, and rod-cells that of light—and form-perception.

According to several authorities, in cases of congenital nystagmus, there is always a maldeveloped macular area; and the constant switching of the eyes is an instinctive search on their part for a position in which the retinal image will fall upon the point of clearest perception. Since, to all practical purposes, this point (the macula) is non-existent, or non-functioning, the eyes are forced by instinct to keep up their constant search for that which can never be found.

The macular area in man reveals a preponderance of cone-cells while the extra-macular area presents a larger proportion of rod-cells—this proportion increasing as we approach the periphery of the retina.

In twilight the macular area becomes relatively non-functioning; this is evidenced by our decreasing ability of direct vision as nightfall approaches. The light-stimulus necessary to adequate stimulation of these cone-cells is lacking; it is sub-liminal—below their threshold of sensitivity. In this condition, the process of vision must be mainly carried on by the extra-macular area, the area whose chief function is that of light and form-perception. With the macular area non-active direct vision is impossible; only indirect vision remains.

The miner, forced by his occupation to remain hours at a stretch below ground and without proper illumination and this is true par-

ticularly in English mines where nystagmus is prevalent, must necessarily experience during this time only the equivalent of twilight vision; as I have stated, such illumination is below the reaction threshold of the cone-cells of the macula. Hence, the functioning of the macular area is relatively lost during this time.

To all practical purposes there is that which might be called "macular occlusion," or "macular anopsia."

As in amblyopia ex anopsia, those nerve pathways which have not been in use degenerate functionally. Organically they may be perfect; the nerve-fibers may be sound, but their synapses, or connections, become more or less impermeable to the passage of the impulse; the reflex arc is obstructed and temporarily destroyed (functionally).

It is the opinion of the author that partial non-use of that part of the visual pathway which carries the impulses originating in the cells of the macular area results in a degeneration of function of such a pathway, and a functional amblyopia of the corresponding portion of the visual field. For he assumes that what may be true of a whole nerve-tract may be likewise true of a component part of that tract. If you will pardon the home-made terminology, we find in the case of miners, working so constantly in the equivalent of twilight illumination, a "macular cone-cell amblyopia ex anopsia."

Since the instinctive desire to achieve a focus upon the macula is thwarted by the malfunctioning of the macular elements, it no longer being the point of clearest vision, we must assume the presence of a condition analogous to congenital nystagmus. As I suggested before, we find an instinctive constant search for that point of clearest vision which cannot be found.

Any correction of this condition, barring consideration of pathological factors, must be directed towards the restoration to usefulness of that pathway which represents the fibers originating in the cone-cells of the macular area.

To achieve this there might be tried the treatment used in the correction of amblyopia ex anopsia—but instead of occlusion of the whole eye we should want occlusion of the extra-macular area. Contact lenses, as developed by the Germans, embodying the principle of the pin-hole, might constitute a step in the direction of a more adequate solution of the problem than we now have at hand.

The theory here presented is forwarded with the idea of provoking discussion. The author regrets that he has been unable to study at first hand the condition of which he writes, and admits that his thesis is based upon his study of physiology and psychology, together with that of writings of other authors upon this ocular abnormality.

DR. FRED M. DULA,
MORGANTON, N. C.

# HYPEROPIA

Being the Second Thesis of the B. Woodward Hazel Award of the Optometrist Club of Baltimore.

A. T. Liachowitz, Opt.D.
Mahoney City, Pa.

*Introduction*

In general it may be stated that the refractive power of the media of an eye, as compared with the position of the retina, determines the condition of that eye, whether it is emmetropic or ametropic.

Emmetropia defined, is a state of refraction of the eye in which, while the ciliary body is at rest and the accommodation relaxed, parallel rays of light after entering the eye are brought to a focus upon the retina. It is the perfect or ideal condition of the eye.

Ametropia is a general term applied to the eye when an error of refraction is present. It is opposite in meaning to emmetropia, but is not to be interpreted as a pathological condition as it is mostly due to the anatomical structure of the eye and as such, is a physiological condition. The ametropia, according to Tscherning, may be due to (a) anomalies of the "screen" (axial ametropia), (b) refracting surfaces or the (c) indices, either singly or in combination. Hyperopia is one condition resulting from these anomalies.

Inasmuch as this paper is an attempt at a lucid description of hyperopia, it will be confined to this subject, excepting when the association of certain other errors of refraction and related ocular functions compel digression.

*Hyperopia Defined*

The word, originally hypermetropia, was coined by Donders and its abbreviation to hyperopia, by Helmholtz, has come into accepted use, as the designation of a certain refractive error.

It defines that condition of the eye when in a state of rest, parallel rays of light passing into the eye, fall upon the retina before coming to a focus.

It is evident then, that a hyperopic eye, in a state of rest, can receive only convergent rays of light at a focus upon its fovea. Since, however, convergent rays are not to be found in nature and are, therefore, artificial, a transparent medium having the proven property of converging light rays—a convex lens, is superimposed to focus the parallel rays of light upon the fovea.

The following definition of hyperopia[1] is regared as authentic:

Hyperopia is a condition of the eye, when the refractive media has not sufficient refractive power as related to the anterio-posterior diameter of the eyeball.

*Classifications of Hyperopia*[2]

1. Manifest Hyperopia is represented by the strongest convex lens with which an eye can maintain distinct vision. It is that amount of the total hyperopia which can be corrected by convex lenses.

2. Latent Hyperopia is the amount of total hyperopia which can not be corrected by convex lenses, but is overcome constantly by the action of the accommodation. It may be further defined as the amount of hyperopia which a spasm of ciliary muscle (tonicity-accommodation) does not permit to become manifest.

3. Total Hyperopia is the amount represented by the Manifest plus Latent, which constitutes the full hyperopia.

4. Facultative Hyperopia is that part of Manifest which the patient can overcome by the use of accommodation. (A voluntary use of the accommodation). A patient wearing a correction for this part of hyperopia can see equally well with or without lenses.

5. Absolute Hyperopia is that amount of hyperopia which the patient cannot overcome by accommodation. Facultative Hyperopia in youth becomes Absolute in advanced years. Absolute Hyperopia exists whenever the amount of the defect is such that it cannot be overcome by accommodation or when the ability to accommodate has ceased.

6. Relative Hyperopia exists when the accommodation is assisted in its efforts by the action of the internal recti muscles. By relieving the innervation of the interni—through convergent squint—and permitting this energy to aid the efforts of the ciliary body, the accommodation is increased and the Facultative Hyperopia is supplemented.

*Etiology*

In the causes of hyperopia Thorington states: "It is a well-known fact the eyes of the new-born are, with comparatively few exceptions, hyperopic." He further continues, stating, that such eyes are supposed to grow in their anterio-posterior diameter and at adolescence to reach that stage of development called emmetropia. However, according to Fuch[3], this ideal condition of emmetropia is very rarely attained; the length of the eyeball not increasing in proportion to the strength of its refractive system. Since the ordinary hyperopia of children and young adults is an axial hyperopia, it is quite safe to say that the cause lies in the process of development, wherein the eye has not sufficiently elongated to produce emme-

tropia. Therefore, a very large proportion of hyperopia may be regarded as a normal physiologic ocular anomaly.

Beside this natural condition of hyperopia, other forms of hyperopia may result from causes such as are enumerated below:

1. Modifications in the curvature of the cornea.

2. A decrease in the index of refraction of the media.

3. Changes in the curvature, position or the density of the crystalline lens, such as: Due to old age, a flattening of the lens by sclerosis of its fibers.

4. Any pathological condition which will cause a flattening of the cornea.

5. The removal of the lens following a cataract operation.

6. Abnormalities of development.

*Symptoms*

The prevalence of hyperopia which has been estimated from 80 to 90 per cent at birth decreases to about one-half that amount amongst children of sixteen years. This decrease in hyperopia which continues gradually until physical maturity is reached, frequently is transformed into a myopic state of refraction, as evidenced by individuals whose environment and vocation predisposes them toward myopia. After the age of twenty the hyperopia remains quite constant, though as one approaches the presbyopic age, due to the lessening of the accommodative tonicity, the hyperopic error thus hidden becomes manifest and so increases the demand for correction. With the advent of later years the hyperopia usually increases some.

Were it not for the power of accommodation, hyperopes would have indistinct vision for both near and far distances. However, this accommodation which they are forced to use more or less excessively, even when looking into the distance, is productive of certain almost infallible symptoms, which when correctly interpreted prove a state of hyperopia. The readiness with which the condition is made discernible, of course, depends upon the skill of the refractionist and the degree of the refractive error. The following symptoms classification are aids to proper deduction:

1. Cephalalgia (headaches) stand out prominently as a symptom of hyperopia. There are four main types:

a. Frontal headaches which are nearly always caused by asthenopia, hyperopia or hyperopic-astigmatism.

b. Fronto-temporal headaches total about 80% of all headaches. Approximately 90% of this amount is due to ocular disturbances.

c. Occipital headaches are a fairly frequent type, but are not often due to ocular discomfort. Muscular anomalies—i.e., a fusional disarrangement—will cause an occipital headache.

d. Vertex headaches are usually due to constitutional disturbances and are rare as a symptom of ocular defects.

e. "Sick headaches," as they are commonly called, are largely due to eyestrain.

2. Blepharitis marginalis, styes (hordeolum), conjunctivitis and lacrymation are external signs. The ophthalmoscope may show a congestion of the choroid and retina which often go together with a blepharitis and conjunctivitis. A small optic disc, frequently with a tendency toward ovality in the vertical meridian, is observable with the ophthalmoscope. The ovality being due to an associated astigmatism.

3. Complaints of blurring or dimness of print during reading, especially apt to occur by artificial light.

4. Assimilation of myopia. (The hyperopia being of an amount beyond the limits of accommodative compensation, the close work is held close to the eyes thereby creating large retinal images. Hence, assimilation of myopia.)

5. Ability to see normally for distance but imperfectly for near.

6. Position of patients near point of distinct vision.

7. Landolt[4] has calculated the circle of rotation of the normal eye as being situated about 13.5 m/m behind the anterior pole, or 10 m/m in front of the posterior pole. In a hyperopic eye, therefore, the circle of rotation is situated relatively further back. Were it possible to ascertain this fact conveniently it would be considered, theoretically, as a symptom.

*Relation of Accommodation and Convergence to Hyperopia*

In uncorrected hyperopia there is a disturbance of the normal relationship between accommodation and convergence. All authorities are agreed that the origin of "persistent headaches" lies not so much with the ametropic error itself, as with the interference of the co-ordinated accommodation and convergence functions.

Fortunately the ratio of these two functions is not held to an unelastic quantity. Within prescribed limits, which are ample for most conditions, the flexibility of the amplitudes of the related functions permit a compensatory adjustment of one to the other. Were the expenditure of accommodation and convergence an absolutely fixed quantity, every hyperope (and ametrope) would have to choose between two alternatives, as Atkinson points out: either to see distinctly but double because of defective convergence, or else to see singly but indistinctly because of his hyperopia. Since the stimulus for accommodation normally stimulates the act of convergence and as the hyperope is obliged to accommodate for objects at infinity, he quite naturally must counteract this associated convergence impulse. To permit himself to converge, as already stated, is to be penalized by diplopia. Therefore, the necessity to repress

convergence is aroused, causing a condition of unstable equilibrium between the positive use of accommodation and the negative restraint upon convergence, this of course, in virtue of his desire for singleness of vision.

Such a state of affairs, when of a degree of hyperopia to be appreciable, is bound, at some time, to produce a serious disruption of the co-ordination between accommodation and convergence, resulting not so much in an insufficiency as in an inefficiency of both these fuctions. The positive relative accommodation is diminished, relative convergence is exaggerated and manifest esophoria is almost certain to ensue—since every hyperope has a potential esophoria, whether evident or not—normal to his hyperopia.

Esophoria present in hyperopia is normal. Usually the correction of the hyperopia brings about an orthophoric state. Exophoria is infrequently associated with hyperopia and the causation quite often is obscure. Mostly it is the result of suppression of one eye, and the consequence of the simulation of myopia. A prescribed method of exercises will rectify the muscle imbalance with due care given to the hyperopia.

Accommodative anomalies in hyperopia are common. It has been established that the total or true amplitude of accommodation cannot be exerted for any marked length of time, or for ordinary purposes. A reserve of at least one-third is required, though this may vary with individuals. Depending, of course, upon the amount of hyperopia and the amplitude of accommodation, disturbance of this reserve is a factor that contributes a satisfactory explanation for the complexity of symptoms and eye discomfort experienced by most uncorrected hyperopes.

Inability to sustain accommodation. This condition of ill-sustained or difficult accommodation is usually due to the constant maintenance of accommodation for the hyperopia with resultant strain, or to the physiologic change in the lens and ciliary body, and is doubtless the seat of annoyance in early presbyopia.

Inertia of accommodation constitutes a difficulty or sluggishness in changing from one accommodative state to another such as an eye-active hyperope experiences. This occurs especially when the peak of accommodative powers is in use.

Inequality of accommodation is sometimes due to the difference in amount of hyperopia in each eye. It frequently is due to a greater weakness of the ciliary muscle or greater rigidity of the lens in one eye as compared to the other, or the amplitude may not be the same.

Excessive accommodation. Due to ciliary overaction, which is the hyperopes lot, the almost continuous demand brings about certain deleterious consequences, which becomes evidenced in a number of ways. In the young and healthy the overtask may be main-

tained without apparent harm for a while, but in patients who have impaired health or who may be somewhat advanced in years, the ciliary muscle fatigue is set forth in symptoms, characteristic of this condition, such as have been previously outlined. As a further consequence of the increased work placed upon the ciliary body of a hyperope, this organ becomes, according to Posey[5], excessively strong and abnormally increased in size or development. These circumstances may bring on a condition of a spasmodic contraction of the ciliary body to the extent of constantly exerting some degree of muscular contraction, aside from its own inherent tonicity. The long, continuous and excessive use of accommodation, therefore, will ultimately induce this locking of the accommodation which is not readily released and is a source of considerable difficulty toward the measurement and correction of the refractive error.

The spasm thus induced may be of two types: tonic or clonic.

Tonic spasm is the steady and persistent muscular contraction, without intermission, of the ciliary body. Increased latent hyperopia and pseudo-myopia is the resultant effect.

Clonic spasm is the intermittent, spasmodic contraction of the ciliary muscle which yields more readily to dispersal and the complete relaxation of accommodation. In this instant the latent hyperopia is increased only when the clonic spasm is present.

Such spasms may occur at any age up to fifty years and possibly beyond. The most important subjective symptoms of excessive accommodation include:

1. Sudden variability in vision in reading the test letters for distant vision.

2. Changeableness and varying intensities of clearness of the lines on the fan, clock-dial or astigmometer wheel.

3. The variability of the correcting lenses accepted by the patient.

4. The reported sensation of contraction or drawing in of the eyeball itself due to contracture of the muscles.

The objective symptoms of accommodative spasm include:

1. The ophthalmoscopic examination shows the refractive condition of the eye to be considerably different from the glasses accepted on subjective testing.

2. The retinoscope may show decided variations in the refractive condition in the relative comparison of dynamic and static findings.

3. In cases associated with astigmatism the ophthalmometer may differ considerably with the subjective astigmatic findings.

4. Deduction from objective and subjective findings may show distant vision to be pseudo-myopic.

*Punctum Remotum and Punctum Proximum*

1. The far point of a hyperopic eye may be said to be at a negative finite distance. Inasmuch as a hyperopic eye can only bring convergent rays to a focus while in a state of rest, the light reflected from a point on the retina of an uncorrected and non-accommodated hyperopic eye emerges divergent. These divergent rays, if they were prolonged backward, would meet at a point back of the retinal plane, from which they appear, theoretically, to emanate. This point then, would correspond to a focus conjugate to that of the retinal focus. The convex lens having its second focus ($f^2$) coincide with this far point of the eye (i.e., the distance) would be the correcting lens required to make the hyperopic eye emmetropic for distance.

The far point position may be established in an accurate manner through static retinoscopy. The subjective method, of course, can also be used.

2. The near point of a hyperope is always further removed than that of an emmetrope or myope of approximately the same age. This is readily comprehended when the accommodation a hyperope expends is considered. Thus, the injurious effect of hyperopia upon vision at near points furthermore finds expression in the fact that presbyopia sets in at an earlier age than in emmetropic eyes.

The distance of the near point depends upon the amount of accommodation remaining after a hyperope accommodates for infinity. Except in presbyopic patients whose accommodation may be entirely gone, the punctum proximum is always an actual measureable distance within infinity. Difficulties are encountered quite often in the effort to locate this close point. Atkinson states, "the near point being a function of active muscular effort is hardly the same in the same patient at any two successive examinations, depending upon conditions of general health, fatigue, mental and physical concentration, etc."

Several methods, especially objective, have proven most satisfactory in the finding of the near point, especially when the amplitude of accommodation is desired to be known. Sheard's technique[6], employing dynamic skiametry as a basis, has shown itself to be very accurate.

*History of Hyperopic Patient*

Inquiry as to the patient's awareness of ocular annoyances and symptoms of defects having been made and the facts ascertained, together with other available data gathered from observation, the history of the patient is next desirable. The subject's age; mode of occupation; condition of illumination; whether there have been injuries to the eye by blows or minute particles such as cinders, steel splinters, etc.; working environment; nature of constitutional disturbance, if any; record of any other members of the patient's immediate family wearing glasses, *et al.*

It is quite obvious facts of this sort are essential for the proper and complete recordance of the patient's case for present and future reference, and towards a complete understanding of the etiology of the condition. That it may also have an ultimate effect upon the prescribing of the correction for the refractive error will be readily assented to.

*Diagnosis of Hyperopia*

Hyperopia[7] quite often may be recognized from the following external signs (with due consideration for symptoms noted prior):

1. Blepharitis marginalis if present is generally due to hyperopia.

2. Hyperopic eyes are said to be small and to have small pupils, which facts are generally confirmed.

3. A narrow face and short interpupillary distance is quite often indicative of hyperopia.

4. 95% of all cases of convergent strabismus are due to hyperopia and accompanying defect, astigmatism, which is usually present.

5. Hyperopes, with few exceptions, have excellent distant vision, often 20/20 or better.

6. The patient relates a history of accommodative asthenopia, with or without headaches, coming on during or after the use of the eyes.

7. The distant vision may remain unchanged or may be improved with the addition of a convex lens, which latter would be impossible with an emmetrope or a myope.

8. The position of the near point of a hyperope, as related to that of an emmetrope or myope, is always further away, for the same age.

9. The tests for determining hyperopia as to its presence and amount are facilitated through the use of the ophthalmoscope, retinoscope, ophthalmometer; subjective procedure by trial case and chart. The results thus obtained are the essential factors for analysis. The muscle-investigation findings being the only additional data required.

*Examination and Correction*

First. The preliminary examination should include the history and symptoms as expressed by the patient, careful search for external signs of pathology, as well as the pupillary reflexes and the recordance of the visual acuity without lenses and with, if the patient possesses them.

Second. The opthalmoscopic examination though primarily used to examine the media and the interior of the eye—that is, the fundus and its details—will disclose the nature of the ametropia and an estimate of its amount when used efficiently. The strongest convex lens with which the fundus may be distinctly observed repre-

sents the amount of hyperopic error present, if any. The disc in an eye that is hyperopic usually present a smaller diameter than in myopia or emmetropia. The prerequisite to proper estimation of the refractive error and use of the ophthalmoscope is relaxation of the observer's accommodation and correction of his own refractive error, and distant fixation by the patient.

Third. The Ophthalmometer though used primarily to record corneal astigmatism, through its measurement of the corneal radii and dioptric power, permits a comparative analysis of the findings in relation to an average or normal cornea. The deduction indicating a possible curvature hyperopia or axial hyperopia. The accepted radius of 8 m/m or 42 dioptres being the fixed power[8], a variance toward a greater curve (causing, of course, lesser corneal power) indicating a possible hyperopia due to the cornea. This, however, may not be sustained.

Fourth. The Retinoscopic method of obtaining the nature and measure of the refractive error is the most accurate and far superior to that of the ophthalmoscope for this purpose, as there is no need for allowances for the refractive error or accommodation of the practitioner. Static retinoscopy, specifically, finds the correction for manifest hyperopia for distance and thus the far point of the patient.

Dynamic retinoscopy as applied to a hyperope discloses:

1. Manifest refractive error )
2. Latent hyperopia ) total refractive error.
3. Lag of accommodation )

(Relative accommodation.)

With the application of dynamic retinoscopy to the technique originated by Sheard the true near point can be located.

Fifth. The Trial Case and Chart. This method, especially with the use of a refractor, furnishes a means of comparing the objective findings with those obtained subjectively. Care should be taken in this test to adjust the trial frame to the position of lenses as applied as a correction, thereby avoiding a disturbance of lens effectivity.

The far point is obtained by test chart readings.

The near point can be obtained by several methods subjectively, the Jaeger test type is in general use.

Sixth. The writer employs the so-called Fogging System throughout the retinoscopy (both dynamic and static) and subjective test. The reason for its use should need no accounting. Sufficient to state that it controls or tends to control ciliary activity.

Seventh. Muscle examination. No refraction has been completed without investigation of the balance of the extrinsic muscles. The phoria tests at distance and at some close point (usually 13 inches) followed by investigation of the reserve powers (positive reserve fusion) at 13 inches. Any disturbance that may be indicated by the

findings should lead to complete examination of the duction power at distance as well as further fusional tests close.

Eighth. Correction. Atkinson states, the most important part of the problem in every hyperopic case is to prescribe a correction which will permit the patient to achieve a comfortable co-ordination between accommodation and convergence at the point at which it is most desired, and on its successful performance depends the satisfactory fitting of the eyes.

The scientific analysis of the refractive data, the comparison and deduction of the results objectively and subjectively obtained will lead, usually to a definite decision as to the state of the refractive error being a case of simple hyperopia; and so prescribe the correcting lenses. The correction of the ametropia immediately brings the two eyes more nearly in correspondence with an emmetropic binocular combination of accommodation and convergence. The continued use of the correction will also tend to cause the smaller residual differences to disappear.

A searching investigation into the accommodation-convergence relation should be accorded every case where normal visual acuity cannot be readily obtained. The degree of flexibility and the patient's ability to control or enforce this particular functional mechanism, governs the ultimate value, form and character of the lenses prescribed to correct the ametropia.

The divergent views expressed by authorities on the muscular phenomena of the eyes are an indication of the greater need for further continued studies of this and other important phases by the profession of Optometry. But, it is becoming more and more evident as Optometrical research advances, that muscle imbalance exacts an enormous tribute from the comfort and efficiency of mankind, and that it is in the realm of Optometry to not alone alleviate such plights, but also to prevent them.

## BIBLIOGRAPHY

1. Definition by Dr. Edwin F. Tait, Professor of Theoretic Optometry, Pennsylvania State College of Optometry, Philadelphia, Pa.
2. J. Thorington. Methods of Refraction. First Edition, p. 151.
3. A. Duane. Fuch's Textbook of Ophthalmology. Seventh Edition, p. 188.
4. E. and M. Landolt. Defective Ocular Movements. First Edition.
5. W. C. Posey. Hygiene of the Eye, p. 30.
6. C. Sheard. Dynamic Skiametry.
7. J. Thorington. Methods of Refraction. First Edition, p. 152.
8. M. Tscherning. Physiological Optics.

DR. A. T. LIACHOWITZ,
VICTORIA THEATRE BUILDING,
MAHANOY CITY, PA.

# MECHANICAL PRESSURE OF THE EXTERNAL RECTUS AGAINST THE GLOBE OF THE EYE CAUSING A LENGTHENING OF THE ANTERO-POSTERIOR DIAMETER

Robert K. Parker, O.D.
Fair Haven, Vermont

In the discussion of any new case in which nature doesn't seem to have followed the straight and narrow pathway of what in textbooks is called "a typical case of—," we can but theorize in most instances as to the reason for which such departure was made. Two different optometrists, given the same problem, would possibly develop two new theories or perhaps a revision of the thoughts of one of the fathers of optometry. The results of each, while in most cases of value to the patient, always profit the optometrist by the added information gained in the pursuit of a satisfactory solution of his particular question. How much more so, when he reads in the scientific journal of his profession this same problem, looked at and discussed from an entirely different angle or else some friendly criticism of a point in question.

These are the thoughts which came to the writer while reading "The Effects of Stimulus to the Internal Recti" by Dunning in Vol. V, No. 5 of the American Journal of Optometry, wherein he presented an entirely different viewpoint of a case discussed in the preceding issue by Koch under the caption, "Exertion of Internal Recti Causing Change of Refraction—A Case Report."

First let us look at the case from the innervational theory. Surely this presents a simple explanation—exophoria—innervation sent to the interni to secure extrinsic balance but at the same time a conjugate innervation reaching the ciliary muscle and curvature myopia resulting therefrom.

But will "any increase in the antero-posterior axis of the globe of the eye" result in "increase of corneal curvatures"? Here we quote from "Ophthalmometry" by Ryer: "Observations show that the high power cornea, suggestive of myopia, frequently accompanies the typically small hyperopic eye, while the typically large myopic eye often possesses a low power cornea," which goes to show that we can secure no positive indication of myopia (or hyperopia) from the radii of corneal curvatures. The change in axial myopia is usually at the posterior division of the sclera, according to Fuchs, where there

is a stretching and sometimes the formation of a staphyloma posticum of scarpa, partly due to the fact that it is here that the sclerotic is more yielding and partly for a reason which we shall cite presently.

Now we have the mechanical theory to consider. Koch in his discussion of this case states as the cause of the increased antero-posterior axis in near vision, a pulling of the internal recti, while Dunning explains that the arrangement of the extrinsic ocular muscles is such that while under some conditions there might be a shortening of the globe of the eye along this axis, there could not, however, under any condition be a lengthening of it due to pulling power of the recti muscles.

Here let us refer to Fuchs and find out what in his opinion caused the increase of the long diameter of the eyeball producing axial myopia. Several well-known etiological factors are found—inherited predisposition, malacic tendency of sclera, accommodation, and excessive near use of the eyes for long periods of time under adverse conditions. It is especially the last of these with which our problem is concerned as it is in near use that the refractive condition of these particular eyes is by some means changed. We go further and see that contraction of the internus during convergence required for close application cannot of itself produce the lengthened axis. But what happens to the externus when its antagonist is in the contracted state? The answer is, in my belief, that the antero-posterior diameter of the eyeball is lengthened; not only by the pull but rather by the pressure of the externus on the temporal side of the eyeball causing a flattening of this part which is necessarily accompanied by an increase of an axis where the resistance is weakest, which, as we have seen is at the posterior pole of the eye around the optic disc.

Thus we have the mechanical and innervational theories and may the material herein, though not original, aid in the consideration of this kind of myopia from the mechanical standpoint.

DR. ROBERT K. PARKER,
FAIR HAVEN, VERMONT.

# OCULAR PSYCHOMETRY

Carl F. Shepard, O.D., D.O.S.
and
Wm. Arthur Mendelsohn, Oph. D., Opt. D.
Chicago, Ill.

## CHAPTER IX

Explanation of the various devices constituting the armamentorium for corrective optometry will be absolutely meaningless to the reader who does not first grasp the essential fact that methods described herein seek to restore and to develop perfectly natural, normal function in their proper sequence; a plan completely ignored by every technique (known to the authors) which employs prisms or stereoscopes in any form.

Optometric literature is abundantly supplied with discussions of stereoscope and prism "exercises." Therefore, this limited article will not include repetitions, although the authors wish to state that the merit of prism and stereoscope training in its proper place is fully recognized and freely admitted.

The most serious criticism of fusion training systems so ably and enthusiastically advanced is not of the systems themselves, but of the too obvious unscientific attitude "this is the only means." One is led to wonder how human eyes ever managed to attain normal development prior to the introduction of prism training only a few years ago.

The following outline must not be misconstrued as methods for "fusion training," but rather methods for the development of those more primitive and more essential functions which precede normal, natural fusion and make it possible.

The first evidences of ocular normality in the human infant are the pupillary reflex and a conjugate upward movement of both eyes and the upper lids.

The second appearing evidence of visual normality in the human infant is the tendency of each eye as a separate unit to fixate conspicuous, and especially, moving objects not too far removed from the line of direct vision. The only dispute between internationally recognized physio-psychological authorities concerning this function is

whether it be an inate or an acquired reflex. It appears during the first five weeks of life.[43]

In many cases of squint and amblyopia, this most primitive function is either totally absent in the subnormal eye, or, if present, is far from normally prompt and accurate when the stimulus to fixation appears in the field opposite the abnormal resting position. For example, in a case of convergent squint of the right eye, fixation of objects in the temporal field is usually inaccurate, or visibly slower than fixation of objects in the nasal field. Therefore, in all such cases, the new corrective optometry which we advocate proceeds first of all to develop normal monocular. fixation-reflex. The means employed bring an alternately visible and invisible, rhythmically moving, conspicuous object, such as a light in a darkened room. Monocular fixation training is, of course, continued to encourage normal development of the connate function, the ability to follow and maintain fixation of moving objects through all normal ocular excursions. Such fixation should occur and be maintained even when the patient's attention is focused upon some other than the visual sense; for example, even when engaged in conversation. Upon careful investigation, it will be found that surprising numbers of modern eyes fail in this most primitive function in that attention must be focused upon the visual act for its proper performance, and fixation becomes very inaccurate when attention is diverted by conversation.

Nature provides that whatever moving object entices one eye to fixation and excursion is visible as well to the companion eye. The normal child never has one eye open and the other closed. The ability to "wink one eye" is an enviable accomplishment even to the six-year-old youngster. Obviously, then, both of a pair of normal human eyes are led by identical individual experiences through parallel excursions during the first years of normal life. Being led independently through parallel paths leads to the habit of concomitance. Concomitance usually makes its appearance not later than the third month of life, and can then be demonstrated by observing the action of one eye behind an opaque covering, while the companion eye is led through a series of excursions by a moving fixation object.

One may readily conceive of a wide variety of monocular inhibitives, such as ametropia, injury, or pathology which by interrupting for a time the parallelism of synergistic ocular experience may reasonably be held responsible for imperfect concomitance. In other words, the eye receiving the greater experience in the function of fixation and excursion becomes the dominant eye, while the less experienced eye becomes the "floating eye."

When discovered ocular abnormalities are found to include imperfect concomitance in certain or all excursions (a not uncommon circumstance), corrective optometry seeks to reestablish normal concomitance as the second step in development. The purpose is to

lead each eye independently through parallel excursions. The means employed being a rhythmically moving, projected fixation target which, through following constantly a geometrically exact path, is visible to but one eye at a time. Each eye in turn is led a little distance along this path, the "lead" being constantly (rhythmically or irregularly, as desired) shifted from one eye to the other, so that as soon as equal monocular efficiency in the first described fixation reflex is established, the two eyes are, in effect, led through exactly parallel excursions until the normal habit of parallel concomitance is acquired. Complete success, of course, means that strabismus or heterophoria cease to exist. No matter which way or what angle the eyes are turned, when the case is corrected, they remain parallel even when dissociated or when one is occluded.

The means of securing alternate visibility are so many that an almost infinite variety of effects may be provided. Variety is of inestimable value in securing continued cooperation through avoiding boredom. The various means employed fall into two general groups. The first consists of arrangements of opaque obstacles which occlude first one eye then the other as the pair move through selected excursions. The second group employs complementary colors. The most satisfactory colors for the purpose being the so-called "signal green" and its compliment "signal red." The patient is required to view the moving target through plano "lenses"—"signal red" before one eye and "signal green" before the other. The projected fixation target, by means of ingenious mechanical and optical devices is caused to change from "red" to "green" at the will of the operator; at fixed rhythmical intervals, or at random irregularity. Or, the fixation figure may be doubled by the projection of duplicate forms, one being "red" the other "green."

The color filters before the patient's eyes transmit opposite portions of the spectra. The "green" transmits the shorter, the "red" transmits the longer wave lengths only. Even a single white target is so presented to each eye when seen through these "scopes" that each eye may be considered as following a separate traget, one "red," the other "green," although the two apparent objects occupy almost exactly the same position in space. Because red is least refrangible, it usually appears to be nearer the observer than the green as a result of greater accommodative effort required to focus it upon the retina; and also because of the greater intensity of red light due to its greater penetrating power.

Fusion of "signal red" and "signal green" is an oculo-mental accomplishment superior to normal fusion because there is no normal circumstance under which one eye receives only the one part of the spectra while the companion eye receives only the opposite portion. So that when fusion of signal red and signal green is once established, normal, natural fusion presents few difficulties.

If repetition be permitted for the sake of emphasis, the foregoing principles do not develop fusion, but develop the neural mechanism below the thalmus so that the object of regard is simultaneously imaged upon the two maculae, permitting the cuneus to receive normal, geometrically matched impressions before awareness of form is awakened. Inasmuch as normal fusion is naturally the correct interpretation of already geometrically matched images, the matching having previously been accomplished by normal, equi-efficient monocular fixation and normal concomitance, it is not surprising that normal fusion more often follows restoration of the more primitive functions of coordination, than restoration of normal coordination follows super-normal stimulation of the fusion faculty.

Space will not permit the discussion of details differentiating between the corrective technique for esophoria as compared to exophoria, divergent and convergent, squint, etc., but viewed in the light of better understanding each individual case will fairly shout its need to the conscientious, properly equipped practitioner of modern corrective optometry. The idiosyncrasies of personality encountered can be solved only by experience and genuine professional interest.

The important fact to be remembered is that Nature develops a normal pair of eyes by establishing orthophoria *before* fusion is acquired. Optometry can follow no better authority than Nature when undertaking the same work. In fact, Nature alone can correct her own mistakes. All the optometrist can do is to assist. One readily recognizes the advisability of assisting the development of functions in their natural order rather than in reverse sequence.

The following outline of correction of an hypothetical case of heterophoria or heterotropia is presented as concrete expression of the principles just expounded, and it is hoped that the redundance will be excused for the sake of emphasis:

(CASE:—Any case in which it has been shown by the customary tests that normal coordination does not exist.)

(1) If errors of refraction exist, especially anti- or anisometropia, a correction should be provided and worn at least throughout corrective training.

(2) If after ametropic correction with lenses, acuity is found to be below normal in either eye or both, it should be improved as much as possible. (The next chapter will be devoted to this step.)

(3) If fixation does not promptly follow the appearance of conspicuous objects in any part of the visible field, especially in the field opposite the resting position, the fixation response must be developed to the fullest extent possible in each eye separately.

(4) If the sense of location does not coincide with the line of fixation, such coincidence must be established. The test consists of exposing a light in a darkened room for an interval just sufficient to permit accurate fixation, while the patient is standing a step or

two from the screen upon which the light appears. The light is then extinguished and the patient is requested to place a finger upon the spot where the light was seen. The training consists of repeating the test, and should be with each eye separately, then both.

(5) If either eye is in any degree reluctant to make excursions into any part of the visible field, the reluctance should be overcome.

(6) If either eye tends either to race ahead, or to fall behind the actual movement of a fixation target, the tendency should be corrected by monocular training.

(7) If either or both eyes tend to avoid excursions when attention wanders from the fixation act, the tendency must be overcome by training if possible; avoided by providing rhythm of movement or position of inhibitives; or defeated by constant watchfulness of the attendant in charge of the training.

(8) After each eye separately is capable of functioning to the fullest of efficiency in every respect, mechanical interruptions, or the alternate colored target with the complementary colored "scopes" should be employed to lead the dissociated eyes through parallel excursions until orthophoria is established.

(9) After orthophoria has been established, or at least every other means has been employed in the attempt, the fusion faculty should (if then necessary) be developed and employed.

[The next Chapter by Shepard and Mendelsohn will discuss the principles to be considered in the correction of "near point" incoordinance, amblyopia, etc.]—EDITOR, AMERICAN JOURNAL OF OPTOMETRY.

## BIBLIOGRAPHY

[43]W. D. Zoethout. Physiological Optics, p. 285.

# NOTES ON THE "SPECTRUM" AND ON "HOMOGENEAL LIGHT," BY SIR ISAAC NEWTON FROM HIS MEMORABLE WORK ON "LIGHT," WRITTEN IN 1675, AND PUBLISHED IN THE YEAR 1704[1].

Fay McFadden, Opt. D.,
Rutland, Vermont.

The two preceding papers[2] are correct copies from Sir Isaac Newton's famous work upon LIGHT. In the following papers, I shall not attempt to reproduce the exact spelling or wording, and shall make extracts of such propositions and scholiums as will bear upon a subject which would appear to have much value in our pracical optometry. We are sadly neglecting many of the properties of visible "light" even though Newton and many investigators since his time have investigated and written upon the subject. The book being exceedingly valuable and rare, one will only find it in large city libraries, at best. While there is much else than I shall attempt to recapitulate, nevertheless, it would seem that we might gain some valuable lessons in perusing the experiments upon visibility of objects in homogeneous light when they are decidedly indistinct when illuminated by heterogeneous light. Particularly is this true of some diabetic people where the media have become much beclouded, as well as in a great many cases of incipient cataract where the patients state that black type looks blue, or has fringes of red and blue. To say more here would be to anticipate, however.

Acting upon Newton's experiments it seems reasonably certain that optometry can devise means which will greatly assist asthenopic people to read and see other smaller objects in their life occupations.

*The Spectrum*

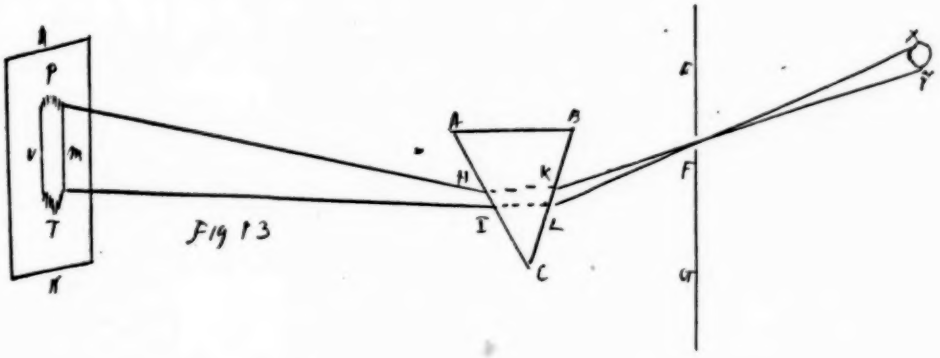
"Exper. 3. In a very dark chamber at a round hole about one-third part of an inch in diameter made in the shutter of a window, I (Newton) placed a glass prism whereby the beam of the sun's

---

[1] [This is the third of four papers inspired by the undoubtedly interesting perusal of Sir Isaac Newton's book "LIGHT." In this paper the author uses, in giving us Newton's experiments, his approximate language, but not the exact spelling or wording as used by Newton in the latter end of the seventeenth century.]—EDITOR, AMERICAN JOURNAL OF OPTOMETRY.

[2] "'A Few Notes on the Decay of Sight in Old Men' by Sir Isaac Newton," F. McFadden, The American Journal of Optometry, Vol. 5, No. 3, pp. 133-135, 1928; and "A Few Notes on the Proposition, 'Lights Which Differ in Color Differ Also in Degrees of Refrangibility' by Sir Isaac Newton," F. McFadden, The American Journal of Optometry, Vol. 5, No. 5, pp. 227-230. 1928.

light which came in might be refracted upward on the opposite wall of the chamber and there form a coloured image of the sun. The prism being placed in this posture, I let the refracted light fall perpendicularly upon a sheet of paper and observed the figures and dimensions. This image was not oval but oblong, terminated by two rectilinear parallel sides, and two semicircular ends. The breadth of this image answered to the sun's diameter, subtending an angle of about a half of a degree which is the sun's diameter. The length of the rectilinear image was about eight inches. We will now let ABC represent the prism itself; XY the sun, MN the paper upon which the solar image is cast, PT the ends of the image and MW the rectilinear sides of the image. The image or spectrum was coloured, being red at its least refracted end toward T and violet at its most refracted end P, with yellow, green, and blue in its intermediate spaces. (Note: Newton recognizes only five colors, not




seven or eight as we have hitherto, nor does he consider three fundamental colors as is sometimes given in text books.)

"Exper. 5. Considering that if in the third experiment, the image of the sun could be drawn out into an oblong form, the same oblong image would by a second refraction made sideways be drawn out as much in breadth by the like dilation of the rays, I therefore tried what would be the effect of such a second refraction. I placed a second prism immediately after a first in a cross position to it, so that in the first prism the beam was refracted upwards and in the second, sideways. I found that by the refraction of the second prism, the breadth of the image was not increased, the image PT was not made broader by the refraction but only became oblique. Sometimes I placed a third prism after the second, and sometimes a fourth after the third and that without any dilation of the image sideways. But I placed another prism behind a board having a hole so that the rays from the first prism could be caused in succession to pass

through the hole and fall upon the second prism, those were more refracted by this prism which by a greater refraction of the first prism were more turned out of the way, and are therefore deservedly called more refrangible.

"I placed a prism at a hole in the window shut, as in the third experiment, and on the opposite wall in the sun's refracted light, I placed an open book, then going six feet and two inches from the book, I placed a lens by which the light reflected from the book might be made to converge and meet again at the distance of six feet and two inches behind the lens and there paint the species of the book upon a sheet of white paper. I noted the place where the paper was when the letters of the book illuminated by the fullest red light falling upon it did cast their species upon the white paper

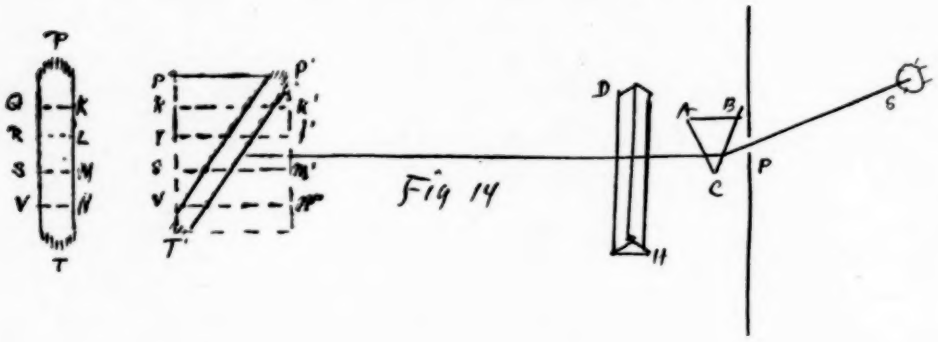


Fig 14

most distinctly; but when those letters were illuminated by blue, I noted again the distance of the paper which was nearer to the lens than its former place by two inches and a half of three-quarters.

"In the second experiment where bodies of natural color were made use of, there was but an inch and a half by reason of the imperfection of colors. Here in the colors of the prism which are more intense and lively than those of natural bodies (he refers to the painted paper with threads wound around it) the distance was 2¾ inches. The prism ought to have a large angle, suppose of 70 degrees, and to be well wrought, being made of glass free from bubbles and veins, and with its sides not a little convex or concave as usually happens, but truly plane and its polish elaborate, as in working optic-glasses, and not such as is usually wrought with putty whereby the edges of the sandholes being worn away, there being left all over the glass a numberless company of very little convex risings like waves. For otherwise, the useless light being reflected every way in the prism and the chamber will mix with the oblong spectrum and help to disturb it. It is difficult to get glass prisms fit for this purpose and therefore I used sometimes prismatic ves-

sels made from broken glass of polished plates cemented together of a prism shape and filled with rain water to which I sometimes added saccharum saturni (sugar of lead) to increase the refraction.

*Homogeneal Light*

"Homogeneal light is refracted regularly without any dilation splitting or shattering the rays, and the confused vision of objects seen through refracting bodies by heterogeneal light arises from the different refrangibility of the several sorts of rays. In the middle of a black paper I made a round hole and caused the light of the spectrum to pass through it and to fall upon a sheet of white paper two or three feet distant from it. In this homogeneal light, I placed flies and such like minute objects, and viewing them through a prism (held in my hand), I saw their parts as distinctly defined as if I had viewed them with the naked eye. (Readers please note): The same objects placed in the sun's unrefracted rays of heterogeneal light which was white, I viewed also through a prism and saw most confusedly defined, so that I could not distinguish their familiar parts from one another. I placed also the letters of small print, one while in the homogeneal light and then in the heterogeneal light, and viewing them through a prism, they appeared in the same case so confused and indistinct that I could not read them; but in the former they appeared so distinct that I could read them readily and as readily as when I viewed them with my naked eye. In both cases I viewed the same objects at the same distance from me, and in the same situation. There was no difference but in the light by which the objects were illuminated, and which in one case was simple, and in the other compound, and therefore the distinct vision in the former case and the confused in the latter would arise from nothing else than from the difference of the lights."

There is a very strong indication here that homogeneal light could be used with distinct advantage in many ways, and by no means is it unlikely that it would have positive advantages to some of our diabetics and those having incipient cataracts, with possible advantages to many others. Newton has not indicated any difference in visibility in the various colors of light, but we well know that the actinic rays are more numerous in the yellow and orange bands. The prism has power to screen out the various refrangibilities of heterogeneous light probably far better than any other method but it would be rather impractical to use it industrially, so that it would seem best to resort to suitable color filters. With lamps constructed in such a manner as to leave practically pure homogeneous light of high actinic value, it is at once evident that the focalization would fall in one strata of the retina rather than be widely distributed in its depth, since Newton's experiment with pigment coated paper wound with threads showed a difference of focalization of an inch and a half, while the same experiment with pure homogeneal

spectral light showed a difference of two and a half inches. The same factors hold true in the retina in proposition as the focal power of his six foot, two inch lens having a dioptral power of .27 D., the human eye having about 54 D., the ratio being 1:200 which brings the focal depth of heterogeneous light through the entire depth of the retina, whereas heterogeneous light would be concentrated in the percipient layer only, thereby alleviating if not wholly eliminating much confusion. The problem is well worthy of trial, and of the construction of lamps which will very strongly illuminate reading matter and occupational work with a flood of proper light.

DR. FAY McFADDEN,
RUTLAND, VERMONT.

# AMERICAN JOURNAL OF OPTOMETRY

VOL. 5 JULY, 1928 No. 7



EDITORIAL STAFF

DR. CAREL C. KOCH, Editor
209 Yeates Bldg., Minneapolis, Minn.

DR. JACK I. KURTZ, Associate Editor
209 Yeates Bldg., Minneapolis, Minn.



Original papers, scientific communications, clinical reports, society proceedings, books for review, and correspondence should be sent to the Editor.

Annual Subscription, Two Dollars in Advance. Single Copies 25c.

Copy of advertisements must be sent in by the tenth of the month preceding their appearance. Subscriptions, applications for single copies, communications with reference to advertising or other business should be addressed to the Business Manager, Dr. Jack I. Kurtz, 209 Yeates Building, Minneapolis, Minn.

Published Monthly by the
American Journal of Optometry Publishing Association.



The Journal has no objection to the reprinting by other magazines of any of its articles, provided such reprints are properly credited to the American Journal of Optometry.


## THE CROSS CYLINDER TEST

The cross cylinder test was originated by Jackson and was intended to be a refined check test for astigmatism. This cross cylinder was made up of a plus 0.25 cylinder and a minus 0.25 cylinder, the axis at right angles to each other. Since that time, several other cross cylinders of different combinations have been suggested by some other investigators with a view of using them in determining more accurately the amount of astigmatism present in a given case.

The types of cross cylinders in general use as suggested by Lockwood,[1] are:

1. +0.25 D. cylinder axis 90⌣—0.25 D. cylinder axis 180.
2. +0.50 D. cylinder axis 90⌣—0.50 D. cylinder axis 180.
3. +0.75 D. cylinder axis 90⌣—0.75 D. cylinder axis 180.
4. +1.00 D. cylinder axis 90⌣—1.00 D. cylinder axis 180.

Peckham[2] suggests using these four pairs of cross cylinders in this form:

1. —0.25 D. Sph. ⌣ +0.50 D. cylinder axis 180.
2. —0.50 D. Sph. ⌣ +1.00 D. cylinder axis 180.
3. —0.75 D. Sph. ⌣ +1.50 D. cylinder axis 180.
4. —1.00 D. Sph. ⌣ +2.00 D. cylinder axis 180.

There are still two other types of cross cylinders. One is made up of a + 3.00 D. cylinder ground on one side of the lens the other

side being plano. The other cylinder is similar form and is a —3.00 D. cylinder. The two cylinders are mounted with the plano sides together in one ring so that the axis coincide and are superimposed. The power of the cylinder while in this position is *0*. The ring is connected up with a handle which rotates the axis of the two cylinders in opposite directions when it is turned, thus introducing a plus and minus cylinder with axis at right angles to each other. The ring in which these cylinders are mounted is graduated and the cylindrical power produced by turning the handle, can be read off directly from the graduations on the face of the ring. The principle and mechanism of this cross-cylinder resembles very much that of the rotary prism.

The second cross cylinder is made up of a square lens, —0.50 D., cylinder axis 180 and immediately above it is mounted a cylinder of a similar shape and strength but with the axis at 90. The two cylinders are mounted in an oblong frame with a handle at the end. When the lower cylinder is held in the front, the corrected eye a —0.50 D. cylinder axis 180 is added to the correction and when the upper cylinder is held in position, a —0.50 D. cylinder axis 90 is added.

The technic for the use of the cross-cylinder-tests for astigmatism is practically the same no matter what type of a cross cylinder is used, as the principle of the interval of sturm[3] is involved to the same extent with the use of either type. The cross cylinder is held in the front of the lenses in the trial frame[4] so that the axis of the minus or plus cylinder coincide with the axis of the test cylinder in the trial frame, by turning the handle the opposite strength cylinder is brought into place. If the original cylinder in the trial frame corrects the astigmatism, then there should be no perceptible difference in the clearness of the line of small type on the test chart no matter into what position the axis of the cross cylinder is rotated. If there is, then the prescription cylinder must be changed accordingly.

As stated before, cross cylinders were originally used as a fine check test for astigmatism. Lately the cross cylinder has been suggested as an accommodative convergence check test as follows: The cross cylinders are to be placed in front of the correcting lenses. This should cause a slight blur[5] on the Peckham cards Nos. 1 or 2 (these cards are made up of a cross of a series of horizontal lines and vertical lines with figures to one side of the cross and letters to the other) if the correction in the trial frame is accurate. The blur should be equal for the horizontal and vertical lines.

In cases of high visual acuity and especially in accommodative esophoria with small pupils, the higher strength cross cylinders should be used. In low visual acuity, in myopes, in esophoria with large pupils, the lower power cross cylinders should be used.

The cross cylinder test used binocularly, it is contended, will

*reveal the relationship of convergence and accommodation, and will show clearly which one of the two is being used in excess.* When the horizontal lines are the blacker, accommodation must be repressed with plus spheres. When the vertical lines are the blacker, convergence must be suppressed with base-in prism.

Since the cross cylinder has been suggested as an accommodative test some practitioners have immediately incorporated it in their routine examinations. Others again questioned as to *why* should two cylinders of opposite powers with axis at right angles to each other applied before the corrected eyes determine the accommodative requirements of those eyes at the given distance. It is pointed out that accommodation is ordinarily tested and corrected by spherical lenses which have equal power in all meridians, and to use a cylinder which has a maximum power only at right angles to its axis to test accommodation is contrary to accepted optical principles.

Dynamic retinoscopy is accepted as an *objective dynamic test* to reveal the accommodative convergence requirements at the near point. The *cross cylinder check test,* it is claimed, will always show the accommodative convergence relationship. This being the case, then it should be taken as the *subjective dynamic test* for the near point. It would, therefore, follow that the findings of the *objective* and *subjective test* should agree with each other. However, after making use of this test for some time we find that there is a very marked discrepancy between the *dynamic retinoscopic findings* and the *cross cylinder check test.* Upon checking over the records of 150 cases, upon which both of these tests were made, we find the following results:

1. The cross cylinder findings were greater than the dynamic retinoscopic findings by +0.25 D. Sph. in 20 eyes or 6.6%.

2. The cross cylinder findings were greater than the dynamic retinoscopic findings by +0.50 D. Sph. in 5 eyes or 3.3%.

3. The cross cylinder findings equal the dynamic retinoscopic findings in 42 eyes or 14%.

4. The cross cylinder findings are + 0.25 D. Sph. less than the dynamic retinoscopic findings in 42 eyes or 14%.

5. The cross cylinder findings are +0.50 D. Sph. less than the dynamic retinoscopic findings in 52 eyes or 17.3%.

6. The cross cylinder findings are +0.75 D. Sph. less than the dynamic retinoscopic findings in 42 eyes or 14.0%.

7. The cross cylinder findings are +1.00 D. Sph. less than the dynamic retinoscopic findings in 42 eyes or 14.0%.

8. The cross cylinder findings are +1.25 to +1.50 D. Sph. less than the dynamic retinoscopic findings in 42 eyes or 14.0%.

9. The cross cylinder findings are + 1.75 to + 2.00 D. Sph. less than the dynamic retinoscopic findings in 4 eyes or 1.03%.

10. The cross cylinder findings are + 2.25 to + 3.00 D. Sph. less than the dynamic retinoscopic findings in 4 eyes or 1.03%.

In all of the cases under consideration, the dynamic retinoscopy was carried out with the fixation and observation point at 35 cm., the cross cylinder check test at the same distance. Simple hyperopic cases only have been used in this group.

Upon closely studying the figures in the given table, one will find that the dynamic retinoscopic findings and the cross cylinder findings agree in only 14 per cent of all the cases and differ in varying amounts in the remaining 86%. It will also be noted that in 10% of the cases the *subjective dynamic* was greater than the *objective dynamic,* and that in 76%, the objective dynamic was greater. Another point of interest is revealed by looking at percentages under Nos. 3, 4, 5, 6, 7 and 8, each of which is 14% with the exception of No. 5 which is 17.3%. Whether these equal percentages in the several groups just happen to be so as a matter of chance or that there may be some important significance attached to the relationship of these various groups we are not prepared to say just now. It may be that further study and research on this subject using a greater number of cases may bring out additional information.

The use of the cross cylinder has been advocated as a test for astigmatic errors for over a quarter of a century. Schneidman[6], Jackson[7] and Crisp[8] have repeatedly pleaded for its adoption, but in spite of all the pleading there are only a few refractionists, who make use of it, or understand its technic. Yet the soundness of the principle underlying the cross cylinder test for astigmatism has never been questioned. Now with all the questions that are being raised about the use of the cross cylinder as an *accommodative convergence test,* one cannot expect that it will be used more extensively for this latter test than it was used as an astigmatic test.

There are several reasons why the use of the cross cylinder was not generally adopted:

1. Because it is essentially a subjective test, and as such is subject to the many mistakes and misinterpretations of other subjective tests which depend so much on the keenness of judgment of the patient, which is in most cases very poor and unreliable. This factor is beyond the examiner's control.

2. Very few articles have been written on this subject and there are not many places in the literature where the refractionist can gain a clear working knowledge of the technic of cross cylinder testing.

3. There is too much discrepancy between the cross cylinder findings and those of other accepted standard tests, especially in cases when it is used as a *dynamic objective near test,* as was pointed out before.

It is not our aim in writing this paper to discourage the use of the cross cylinder, but rather to encourage further investigation. We can not expect the application of this test to be generally adopted until a more refined technic has been worked out. This offers an interesting field for further study from the standpoint of psychology and physiological optics. J. I. K.

BIBLIOGRAPHY

[1]R. M. Lockwood, Optical Journal and Review. Vol. XLI, No. 19, p. 1252.

[2]R. M. Peckham, The Modern Treatment of Ocular Imbalance, p. 77.

[3]Lionel Laurance, General and Practical Optics, p. 130.

[4]R. M. Lockwood, Optical Journal and Review, Vol. XLI, No. 19, p. 1252.

[5]R. M. Peckham, The Modern Treatment of Ocular Imbalance, p. 66.

[6]T. B. Schneidman, The Cross Cylinder in the Determination of Refraction.

[7]E. Jackson, The Astigmatic Lens (the cross cylinder) to Determine the Amount and Principal Meridians in Astigmatism. Ophthalmic Record, p. 3781. 1907.

[8]W. H. Crisp. A Plea for More General Use of the Cross Cylinder. American Journal of Ophthalmology. Vol. VI, p. 209. 1923.

---

BOOK NOTICE

STRABISMUS: ITS ETIOLOGY AND TREATMENT. Oscar Wilkinson, A.M., M.D., D.Sc. Published by the C. V. Mosby Company, St. Louis, Mo. 240 pages. 120 illustrations. 1927. $10.00.

The C. V. Mosby Publishing Company of St. Louis has also sent us for review, Wilkinson's new work on "Strabismus." The correction of this extrinsic muscular defect, with its unsightliness, has long been a subject of interest to the layman and the ocular practitioner. The history of strabismic treatment may go beyond Hippocrates, but it seems to have been Paulus Aegineta in the seventh century that began definite training of the deviating eye by use of a mask with perforations for the eyes. From then on, the study of the correction of strabismus progressed, possibly rather slow, but definite, to the wave of tenotomies and myotomies of the last century and the early part of the present century. The correction of strabismus by optometric means has not been given much credence by the majority of writers although during the last decade or so the consensus of opinion has been to attempt refractive and amblyopic correction first with operative treatment later. Operations have a cosmetic result but the deviating eye may not function in binocular

single vision as hoped due to ocular discomfort from a marked phoria or amblyopia.

In the chapter on the etiology of squint, Wilkinson presents the various theories and the reasons why he cannot accept them. He cannot accept the muscular theory as the deviating eye straightens in sleep and under a general anesthesia, the excursion of the eye is normal and also because glasses have cured many cases. These facts would not necessarily occur if a muscle was long, short or improperly attached to the globe. He cannot accept the fusion theory as why should the eyes deviate later in life, after the fusion faculty is supposed to be developed. If the fusion faculty should suddenly break down it is difficult to see how binocular vision can be restored by exercising a few minutes a day. Also he cannot accept the accommodation theory of Donders as then all uncorrected hyperopes would squint. Thus he eliminates all theories except that of the nervous which can be best summed up in Wilkinson's own statement that "Muscular anomalies, hypermetropia, the heterophorias, or even a moderate amount of amblyopia, would not cause squint in the presence of a well-balanced nervous system."

The author gives various methods of strabismometry but favors two which he uses in his work—the perimeter and the Holzer modification of the Priestly Smith tapes—with one checking on the other.

Wilkinson advises that the examination of a case of strabismus should be exhaustive and systematic to get as complete data as possible. This means the taking of the history, careful examination of the deviation, acuity, type of fusion, refraction, accommodation and convergence, fundus and the physical condition of the patient. The family physician and the neurologist may be consulted to aid in the prognosis. Care in recording data and the subsequent changes if any, is an aid in the prognosis also.

There are twenty-five well written pages devoted to the nonoperative treatment beginning with the statement that he considers the most important step in the treatment of squint is the knowledge to every mother that squint is amenable to early treatment. Quoting Javal: "The reestablishment of binocular vision by exercise usually requires as long a time as that which has elapsed since the commencement of the deviation." Wilkinson's non-operative treatment consists of: constitutional, optical correction, visual training of the deviating eye by occlusion of the other eye, training of binocular vision or the fusion faculty by means of the amblyoscope, stereoscope and bar reading. He found that glasses were first used for squint in 1845 and were suggested in 1743, although it is not certain if they were used.

Forty-seven pages are devoted to the operative treatment of strabismus which shows that its technic is far more than just "snipping a little muscle."

E. O. F.

# ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania South Dakota and Vermont Optometric Associations.

---

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

## ASSOCIATE STATE EDITORS

DR. E. B. ALEXANDER
*Duncan, Okla.*

DR. A. S. ANDERSON
*Williston, N. D.*

DR. J. F. ANDREAE
*Baltimore, Md.*

DR. A. L. CORRIVEAU
*Biddeford, Me.*

DR. C. H. DEGRAFF
*Monroe, Mich.*

DR. L. P. FOLSOM
*South Royalton, Vt.*

DR. D. A. KINNEY
*Charles City, Ia.*

DR. A. J. LARGE
*Winona, Minn.*

DR. M. B. MEYER
*Wilmington, Del.*

DR. J. K. MORRIS
*Erie, Penn.*

DR. J. S. MURPHY
*Little Rock, Ark.*

DR. C. A. PERRIGO
*Fremont, Neb.*

DR. H. N. SMITH
*Sioux Falls, S. D.*

---

## THE WORTH OF OPTOMETRY

We here quote a few splendid paragraphs from the pen of Dr. Charles P. Cleaves, Minister of the Gospel, Poet and Optometrist of Center Harbor, New Hampshire, who, writing on the worth of optometry, says:

"Its worth looms great in its devotion to a great human need. For the end of all its research, experimentation, experience and recorded science is the fitting of an individual pair of eyes. We live in a world of minds. In creating efficiency for any body through his physical equipment we add to his resources of freedom from besetting poverty, fear, depressive emotions of the haunting sort that are especially leagued with eye-strain. Therein we have a place of leadership in the redemption of childhood from one of its chief, though as yet not fully recognized handicaps. Some accomplishments of eyesight conservation have been statistically estimated but its great possibilities are of the future. The accomplishments of the medical fraternity are a quickening toward opportunity. From Moorhead's interesting study of medical service in the Far East, 'The Way of a Doctor,' a few slogans are worth the emulation:

"1. The optometrist's way is the way of a friend. An ill-nourished, depressed New England shoemaker wandered from home, suffered from hunger and exposure, functionally insane, and was pursued by a friendly mob from whom he ran away in terror. His state of mind as a fugitive, imaginative, fearful; his weakened body

struggling for both freedom and self-preservation; these may be imagined. So may the mind of the sufferer from eye-strain, depressed by inability and desire for relief pursued by the sense of poverty, harassed by hopelessness and the sense that optometrists are a mob. A curious faculty of friendship is its faculty for insight, adjustment and impartation that fits both the expectation and the need. That is so largely a matter of the event between individual and individual that two opportunities are open: First, the mass teaching of ocular hygiene, helping this generation to know both what the optometrist can do and why it should be done and also what the people may do in intelligent care of vision. Second, individual treatment by an efficiency that will keep folks coming, not going, and reduce the necessity of their coming. There will be work enough and glory enough for all.

"2. The way of an optometrist is the way of a deliverer. In China a great medical bogy was 'needling.' A girl of 10 years suffered from ulcers, due to foot-binding; the ulcers were treated by inserting needles, infection and gangrene ensued, one foot dropped off and when she was brought to a mission hospital, both limbs were amputated to save her life. A child's conjunctivitis was treated by the native medicine man, by thrusting a hot wire into the eye to drive out the evil spirit. It was a successful case. The child recovered not only from the conjunctivitis but from the operation and, being blinded for life, had no need of a refractionist. There is equally reckless use of undiseased eyes, coming at last to blindness, in our land of science and skill. The way of an optometrist is the way of a deliverer.

"3. An optometrist's way is the way of an interpreter. Telescopes can be bought. It is yet a common notion that glasses may. In twenty years' practice, I have not seen a person who could wear my personal spectacles. The majority of people are intelligent. Keen, quick minds catch and retain an essential principle or a clearly stated fact. The optometrist may interpret to an individual the mystery of his specific problem. The normal or well-fitted eye rests at a distance, focuses for near, does a few hours of intensive work daily; the uncorrected far-sighted eye focuses for all distances, according to the space; works all day. These are relative truths, the principle is there. Light your room—not the corner where you work. Dip the eye into an eye cup instead of dropping a tiny bath into the eye. Rest the eye before sleeping and it will rest all night. Eyes or mind under tension tend to remain so in sleep. Frame fitting is as important as eye fitting; when Nature made the eye, she took care that vision should pass through a center and we do the same with the lens outside—let me show you how a frame must be kept in line. For the daily and emergency care of eyes, men need simple principles as for the handling of an automobile. Unless we are interpreters we shall not be equal to caring for the optical miseries

of our generation as we may. This is optical service, personal, possible, productive and remunerative, not of the waiter and the platter, but of the dietician and the cook.

"I can enjoy a social hour sitting in a dentist's chair, but have never risen above the depression of seeing any person growing blind. Every case that testifies of a neglected past creates a desire to reach out with longer arms to the mass of growing children or to demonstrate with an extensor voice, the simplicities of prevention These are days of the conservation of time or its impetuous waste. As a brighter mind has said, it once took three sheep 365 days to make a woman's dress. Now three silk worms can do it in an afternoon. The reason why is that the women are willing. If we can create that willingness to have vision properly clad, within a generation, a revolution will be wrought in human thinking, habit and health. It can be done—by the sacrifical element involved in all pioneering, and not by the workers in research, invention and publicity only, but by the optometrist whose devotion is to the individual case, whose frugalities he shares. The material reward may follow in a life time. The success is possible in an afternoon. The fame of twentieth century optometry has a share for him, however unknown, in later generations. No matter. He has fitted his case, and that is the gist of the situation and the success."

* * * * * *

AMERICAN OPTOMETRIC ASSOCIATION

The Annual Convention of the American Optometric Association will be held at Grand Rapids, Michigan, July 22-28. Members of the Association are urged by Dr. Ernest Kickenapp, National Secretary, to attend, as the recreational and educational program will out-do anything previously attempted. Optometrists, however, who are unable to attend may secure a verbatim transcript of the sessions of the House of Delegates by sending $2.00 to Dr. Kiekienapp, Faribault, Minn., at once. The educational program will be conducted by Doctors Sheard, Woll, Needles, Peckham and Koch, on the first two days of the convention. The Michigan optometrists have worked together splendidly to make this convention the finest on record and are anticipating a large registration.

* * * * * *

COLORADO OPTOMETRIC CONVENTION

The Twenty-ninth Annual Convention of the Colorado State Optometric Association was held this month at Denver. Dr. Roy Dean spoke on Optometric Instrumentation and Dr. L. E. Wood spoke on Ocular Imbalances. Dr. Wm. D. McLain of Denver was elected President, the other officers being, Dr. G. W. Masten, First Vice-President; Dr. J. W. Crowder, Second Vice-President, and Dr. J. C. Bloom, Secretary and Treasurer.

* * * * * *

CONNECTICUT OPTOMETRIC SOCIETY

Dr. Glenn D. Sweet announces that the quarterly meeting of the Connecticut Optometric Society will be held at the Elton Hotel, Waterbury, Conn., July 10. Dr. H. E. Jones will preside. Following the business session Dr. Oscar McCulloch will lecture on "Binocular Imbalances."

There will be a combined outing of the Connecticut Optometric Society and Springfield, Mass., zone on Wednesday, July 18. The place and program of events will be reported on by the committee at the quarterly meeting.

* * * * * *

OPTICAL FRAME MATERIAL

Mr. G. D. Rosser, of the Hadley Co., Ltd., England, writing in the Dioptric Bulletin claims that solid gold has a tremendous advantage over all other material for use in making optical frames, though gold-filled material, he admits, enjoys the greatest popularity, this due to the fact that when well made it has most of the advantages of solid material and is somewhat less costly. In discussing the gold-filled he claims that, "The alloy itself is made in three forms: (a) Single plate with a layer of gold on one side and base metal on the other; (b) Double plate with a layer of gold on both sides of the base metal; (c) Wire—a complete casing of gold covering the base metal. The gold is attached to the base metal either by sweating, that is, by pressing together at a high temperature, or by soldering. According to the proportion of the layer of gold to that of the base metal, different qualities are obtained, but the 1/10 12ct. is the one generally accepted by the optical world to ensure reasonable wear. To procure this, 12 carat gold is combined with base metal in the proportion of one part of gold to nine parts of base metal. The base metal may be bronze or nickel silver, and the following table indicates the amount of gold for 1,000 parts in qualities commonly used for optical purposes."

| | 9 carat | 10 carat | 12 carat | 15 carat |
|---|---|---|---|---|
| Gold | 375. | 416.6 | 500. | 625. |
| 1/4 | 93.75 | 104.1 | 125. | 156.2 |
| 1/10 | 37.5 | 41.6 | 50. | 62.5 |
| 1/12 | 31.2 | 34.6 | 41.6 | 52.1 |
| 1/15 | 25. | 27.7 | 33.3 | 41.7 |
| 1/20 | 18.7 | 20.8 | 25. | 31.25 |
| 1/30 | 12.5 | 13.8 | 16.5 | 20.8 |
| 1/40 | 9.35 | 10.4 | 12.5 | 15.62 |
| 1/60 | 6.25 | 6.9 | 8.2 | 10.4 |
| 1/80 | 4.67 | 5.2 | 6.25 | 7.81 |
| 1/100 | 3.7 | 4.2 | 5. | 6.25 |

"From this table it is obvious that the amount of gold on a 1/10 12ct. frame is extremely small (50 parts per 1,000). This small proportion is just enough, provided the manufacture is sufficiently perfect to preserve the gold surface intact."

Rosser also claims that each gold-filled frame, before completion passes through over 200 mechanical operations.

* * * * * *

NORTH DAKOTA ANNUAL CONVENTION

The Annual Convention of the North Dakota Optometric Association will be held at Jamestown on Monday and Tuesday, August 6th and 7th. Dr. J. P. Copeland will lecture on "The Theory and Practice of Streak Retinoscopy" and on "New Thoughts in Dynamic Retinoscopy." Dr. A. R. Schrader will lecture on "Practical Lens Effectivity."

* * * * * *

NEW YORK ACADEMY OF OPTOMETRY

The June meeting of the New York Academy of Optometry was held at 47 West 43rd St. Dr. Franklin D. Seward acted as presiding officer. The new Dynamic Optometer as made by Keuffel and Esser was demonstrated, the consensus of opinion among the fellows of the academy being that the instrument will be a decided adjunct to all refractionists.

* * * * * *

ESSEX COUNTY ACADEMY OF OPTOMETRY

The Essex County Academy of Optometry has recently been organized. Its aims are chiefly educational, though a permanent optometric clinic will probably be established. The officers are as follows: Dr. Joseph Salov, President; Dr. Walter Celschlaeger, vice-president; Dr. B. I. Sinoway, treasurer, and Dr. Charles W. Caspar, secretary. The Executive Council consists of Dr. Fred H. Roever, Jr., chairman; Dr. M. Bookstaber, Dr. C. W. Caspar, Dr. B. I. Sinoway, and Dr. W. Celschlaeger.

* * * * * *

INDIANA ASSOCIATION CONVENTION

Dr. E. G. Wilhite reports that the recent meeting of the Indiana Association of Optometrists held at Lake Wawasee was a splendid success. Dr. H. G. Hill spoke on Psycho-analysis. Dr. Carl Shepard spoke on Muscular Defects and Dr. Ernest Einer spoke on Organization Procedure. The Convention closed with a banquet and a dance.

# SAGAMORE

The name "Sagamore is from the Algonkian —Penobscot Indian word "Sagamore" meaning "a chief." It is fitting that this frame American-made in accordance with American ideas and ideals, should have a name of truly American origin.

## *The Sagamores Are Coming!*

THE Sagamores are on the warpath! Braves and Chieftains, dancing to the tomtoms, dressed in war paint and finest feathers!

But they're kindly warriors, on the warpath of business and profits. Not "scalpers" but "goodwill ambassadors," whose mission is to satisfy and to beautify those who desire the shell type of frame.

Briefly, the Sagamore is a new B & L frame line, beautiful in design and coloring, exceptionally inexpensive, strongly built with a five-barrel hinge, precise in every dimension. Three models are now ready for delivery—the 4116, with skulfit temple, 4117 with formflex temple, and 4118 with cable temple. Other attractive styles will follow soon.

Be sure your jobbers salesman shows you the Sagamore. It is a revelation in price and beauty.

*Look for the four-leafed rivet–* ✤ *-the eternal emblem of good fortune*

PATENTED

*See Our Exhibits at the A. O. A. Convention in Grand Rapids, Mich., July 22.*